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An Investigation into The Role of Artificial Intelligence In The Healthcare Industry

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Abstract:

Healthcare systems are intricate and present challenges for all involved parties. However, artificial intelligence (AI) is making significant strides across various sectors, including healthcare, where it holds promise for enhancing patient care and overall quality of life. The rapid advancements in AI have the potential to change the landscape of healthcare by actively incorporating it into clinical practices. With its growing capability to turn complex and uncertain data into actionable—albeit imperfect—clinical decisions or recommendations, AI can significantly influence healthcare operations. In the dynamic interaction between humans and AI, trust emerges as a crucial element that affects how clinicians adopt and utilize these technologies. This paper investigates the role of clinicians as the primary users of AI systems in healthcare and discusses the factors that influence the trust between clinicians and AI.

Keywords: Artificial intelligence, Machine Learning, Role of AI in Healthcare, Limitation

1. Introduction:

Healthcare systems around the globe are confronted with a critical challenge: rapidly rising costs that exceed the rate of economic growth. This unsustainable pattern poses a serious threat to the very foundation of healthcare provision, placing immense pressure on both public and private health systems worldwide. The urgency of this issue became particularly pronounced with the emergence of the COVID-19 pandemic in 2019, as well as the ongoing conflict in Ukraine. A combination of limited financial resources, an aging demographic, increasing prevalence of chronic illnesses, and the strain on healthcare systems—already overwhelmed by the growing demand for services—has led to significant obstacles. Furthermore, the COVID-19 pandemic has caused severe disruptions in healthcare systems in several countries, including India, Brazil, and Indonesia [1-2]. The demand for sophisticated digital devices has become essential for improving patient satisfaction, facilitating health monitoring, tracking, and promoting better adherence to medication. These advantages are especially important during the recovery period following hospitalization, as digital health platforms can significantly contribute. However, patients are growing more cautious about disclosing their sensitive information, which means healthcare organizations (HCOs) need to build trust by providing transparent, compassionate, and dependable services [3-4]. The progress in biomedical science, which includes areas such as genomics, digital medicine, and artificial intelligence (AI)—along with the specific domain of machine learning (ML)—paves the way for a revolutionary change in healthcare. This change necessitates the creation of a new workforce and the revision of existing standards of practice. Technologies like genomics play a crucial role in this transition. Furthermore, although the term AI has been credited to Sir John McCarthy since 1956, it encompasses a wide range of concepts, and a widely accepted definition continues to be difficult to pinpoint. [5-6]. AI includes a range of technological forms, comprising various computer systems (both hardware and software) that depend on large datasets to function at their full potential. [7-11].

Artificial Intelligence (AI): Artificial Intelligence (AI) refers to the development of computer systems that can perform tasks typically associated with human thinking, such as perception, reasoning, and decision-making. In the field of healthcare, AI is crucial as it processes large volumes of patient data—including medical histories, imaging tests, and laboratory results—to support clinical decisions and improve patient outcomes..

Machine Learning (ML): Machine learning (ML), a distinct branch of artificial intelligence, is dedicated to creating algorithms and models that can independently learn from data without requiring explicit programming instructions. .

AI IN HEALTH CARE: Artificial intelligence in healthcare has the potential to bring about substantial advancements and strengthen patient empowerment by providing individuals with increased ownership of their health. Recently, numerous AI applications have been deployed to improve healthcare services, such as personalizing health information and enabling virtual consultations and remote monitoring. [12] [13].

Our approach included an extensive examination of peer-reviewed articles, based on the framework established by Tricco et al. [14]. This involved seven essential steps: defining and analyzing the study objectives, refining and scrutinizing the research questions, identifying and discussing relevant search terms. [15-21]

2. Role of AI in Healthcare

2.1 AI in Medical Imaging and Diagnostic Services: AI has emerged as a powerful asset in the realm of image analysis, increasingly embraced by radiologists to improve early disease detection and reduce diagnostic errors, thereby supporting preventive healthcare. Furthermore, it acts as an advanced resource for cardiologists, enhancing their ability to interpret ECG and echocardiography results, which aids in their decision-making processes. For example, the Ultromics platform, utilized at a hospital in Oxford, employs AI to analyze echocardiography images, detecting heartbeat patterns to identify ischemic heart disease. In addition, AI has demonstrated promising results in the early detection of various conditions, such as breast and skin cancers, eye diseases, and pneumonia through imaging techniques [22-23]. AI tools analyze speech patterns to anticipate psychotic events and evaluate the features of neurological disorders such as Parkinson's disease [25]. A recent study utilized machine learning models to predict the onset of diabetes, with results showing that an enhanced decision tree tailored for binary classification proved to be the most successful model for forecasting various diabetes-related factors [26]. Furthermore, Gudigar et al. [27] emphasized that various medical imaging techniques, including X-ray, computed tomography (CT), and ultrasound (US), enhanced by artificial intelligence methods, have been essential for the early detection of COVID-19. Their research demonstrated that a range of approaches, such as handcrafted feature learning (HCFL), deep neural networks (DNN), and hybrid models, proved effective in predicting COVID-19 cases. In addition, a recent review provided more insight into the use of CT scans, X-rays, MRIs, and ultrasound for diagnosing COVID-19, underlining the crucial contribution of AI in helping society tackle this formidable virus [28]. Furthermore, a deep learning model known as the transformer has been applied in the realm of medical imaging analysis, encompassing various tasks such as registration, detection, classification, image-to-image translation, segmentation, and video applications [29]. Previous studies have demonstrated the ability of transformers to effectively distinguish between COVID-19 and pneumonia using X-ray and CT scans, thereby responding to the critical need for swift and effective management of COVID-19 cases [30-31]. Another study employed the ImageNet-pretrained Vision Transformer (ViT)-B/32 architecture to detect COVID-19 by examining patches extracted from chest X-ray images [32].

2.2 Introduction to AI in Medical Imaging and Diagnosis:
Gheflati et al. [33] employed Vision Transformers (ViT) to classify breast tissue types—normal, malignant, and benign—using ultrasound (US) images. This method demonstrated greater effectiveness in classifying ultrasound breast images compared to convolutional neural networks (CNNs).

2.2 Virtual Patient Care:
Baig et al. [34] emphasized advancements in wearable technology and its integration with machine learning (ML) and artificial intelligence (AI) within the healthcare sector. This combination has enabled practical patient monitoring and management through virtual care, supported by innovative wearable technology solutions. AI plays a crucial role in the management of chronic conditions such as diabetes mellitus, hypertension, sleep apnea, and chronic bronchial asthma by utilizing non-invasive wearable sensors [35].

2.3Medical Research and Drug Discovery
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Artificial intelligence (AI) is exceptionally adept at analyzing the large and intricate datasets common in medical research [36]. Its applications extend to the examination of scientific literature, the integration of various data types, and the acceleration of drug development. As a result, pharmaceutical companies are increasingly leveraging AI to enhance their drug development processes. Researchers can utilize predictive analytics to pinpoint viable candidates for clinical trials and create accurate biological models [36-37]. Machine learning (ML) is instrumental during the pre-trial phase of clinical studies, assisting with participant selection, organization, and data gathering and analysis. It improves the patient-focused approach, generalizability, and overall efficacy of clinical trials. However, it is imperative to tackle the practical and philosophical challenges that ML may confront within clinical environments. Complementing ML, natural language processing (NLP) has demonstrated potential in various facets of participant management in clinical trials, though the influence of these tools on trial quality and participant experiences is still uncertain. Future research should aim to compare various methodologies to improve participant management strategies [38]. In the field of clinical research, generative AI can be used to create synthetic datasets that enhance diversity and bolster existing datasets [39-40].

Furthermore, AI-powered tools like ChatGPT show potential for enhancing clinical trials by facilitating data collection and delivering insightful information about trials [41]. This capability can help researchers summarize pertinent publications and pinpoint significant findings, enabling them to navigate large volumes of online information more effectively. A ChatGPT-based chatbot could also assist in translating complex medical terminology for researchers.

Nevertheless, the use of chatbots in medical research raises several ethical issues that warrant careful consideration [42].

2.4. Patient Engagement and Compliance

Patient engagement and adherence pose significant challenges in healthcare, often regarded as the last hurdle in transforming health outcomes from inadequate to optimal. Non-adherence occurs when patients fail to follow prescribed treatment regimens or neglect to take their medications as instructed. Increased patient engagement is generally associated with better health outcomes, affecting healthcare usage, expenses, and the overall patient experience [43]. According to a survey of healthcare leaders and executives, less than 50% of patients were actively involved in their treatment plans [44].

To address these issues, the integration of artificial intelligence (AI) has emerged as a promising strategy to boost patient engagement. The use of machine learning (ML) technologies and workflow engines is increasingly common in implementing comprehensive interventions across the continuum of care [45]. Additionally, there is evidence that apps and online platforms that facilitate communication between patients and healthcare providers (HCPs) can increase engagement rates by more than 60%. These healthcare applications are designed to collect, store, and share patient data through cloud technology, allowing users to access information anytime and anywhere, which can greatly improve health outcomes [46].

In the field of rehabilitation, AI is bringing forth innovative advancements. This includes both physical (robotics) and virtual (informatics) aspects. A subset of AI known as machine learning involves advanced techniques for developing algorithms that improve with experience. In rehabilitation, ML has practical applications in areas like perioperative medicine, brain-computer interface technology, myoelectric control, and neuroprosthetics. Techniques from ML are also utilized in musculoskeletal health to evaluate patient data, support clinical decision-making, and enhance diagnostic imaging. An artificial cognitive application has been applied to evaluate rehabilitation exercises based on machine feedback [47-48].

Moreover, wearable technology with inertial sensors can assess whether individuals are correctly executing and adhering to exercise routines [49]. For instance, the adherence to a rotator cuff exercise regimen among typical individuals was evaluated using an Apple Watch and various supervised learning techniques to accurately measure exercise performance across different algorithms [50]. Recent research suggests that AI-powered robotics could monitor patients to ensure proper movements and assist in achieving successful movement execution in the future [51]. Frackiewicz [52] posits that HCPs can bridge the gap between the demand for rehabilitation services and the availability of trained therapists by integrating an AI-driven tool like ChatGPT into rehabilitation sessions. This provides patients with an AI-assisted approach that complements traditional therapy.

2.6 Administrative Applications of AI

Artificial Intelligence (AI) has the capability to reduce administrative burdens by automatically populating structured data fields derived from therapeutic notes, retrieving pertinent information from historical medical records, and documenting patient interactions [53]. Interestingly, a typical nurse in the United States spends about 25% of their working hours on regulatory and administrative tasks [54]. The use of voice-to-text technology has the potential to save significant time for both doctors and nurses [53]. Although rule-based systems linked to Electronic Health Record (EHR) systems are prevalent, they frequently fall short of the accuracy offered by more sophisticated algorithmic systems that utilize machine learning (ML) [55]. Additionally, Li et al. [56] presented a deep learning model called Bidirectional Encoder Representations from Transformers for EHR (BEHRT), which effectively handles various types of data embeddings, such as age, role, visits, and events, to illustrate a patient's clinical background.

3. Challenges in AI Implementation in Healthcare

3.1 Ethical and Social Challenges

The incorporation of AI into the healthcare sector raises a number of ethical and societal issues that are akin to those tied to greater dependence on technology, automation, data utilization, and the effectiveness of Telehealth and assistive technologies. As the capabilities of AI increase, so too do the ethical challenges, particularly concerning accountability in decision-making, the risk of erroneous AI judgments, the complexities of AI verification, and the necessity of safeguarding sensitive information. Additionally, there are worries about the biases present in the data used to train AI systems, the importance of maintaining public confidence in AI developments, the effects on the roles and skills of healthcare professionals, and the potential for AI to be exploited for harmful purposes.

Furthermore, the use of AI in treatment delivery, decision-making, or the management of healthcare devices may lead to safety and reliability concerns. It can be challenging to detect errors introduced by AI, and these mistakes can have serious repercussions [57]. For example, an AI tool intended to forecast complications from pneumonia wrongly advised the premature discharge of asthma patients without taking into account crucial information [58].

With respect to transparency and accountability, important inquiries arise concerning who holds responsibility for decisions made by AI and how compensation should be addressed for individuals affected by AI outcomes. The issues of verifying AI outputs and identifying mistakes or biases are particularly significant with machine learning technologies, which frequently function in opaque manners as they adapt through ongoing learning. To tackle these issues, Explainable Artificial Intelligence (XAI) is utilized to shed light on the internal workings of AI systems, promoting trust and clarity in AI-driven decisions [59]. XAI methods are designed to improve the understanding and dependability of results produced by machine learning algorithms. In the healthcare field, both physicians and patients gain advantages from XAI, as it clarifies the reasoning behind AI's diagnostic conclusions. Recent studies show that XAI increases user trust by offering visual feedback on crucial factors affecting model predictions. Additionally, another study highlighted the necessity for XAI techniques to enhance radiologists' confidence in classification outcomes derived from CT scans, aided by various visual insights into automated processes [60-62].

3.2. Governance Challenges

As AI technologies become increasingly integrated into the healthcare sector, there is an urgent need for robust governance to effectively manage regulatory, ethical, and trust-related issues. Establishing strong governance at the hospital level presents a vital opportunity to address these challenges in the application and use of AI [63]. Additionally, a recent study underscores the necessity of regulating AI technologies within healthcare systems to safeguard patient safety and improve accountability. Proper governance not only enhances clinicians' confidence but also promotes acceptance and leads to significant health outcomes. To address the challenges related to clinical, operational, and leadership elements in the implementation of AI-driven applications, a comprehensive governance framework is crucial [64-65].

3.3. Technical Challenges

From a technical standpoint, AI models should be designed and function in a clear and user-friendly manner to allow healthcare professionals (HCPs) to use them effectively. Nevertheless, there are several obstacles that impede the adoption of AI within the healthcare sector. These challenges include a limited ability to develop and sustain the IT infrastructure necessary for AI implementation, rising costs related to data storage and backup for research needs, and the substantial expenses tied to improving data validity [66-68] Additionally, AI algorithms may encounter various limitations, such as their inability to operate outside the scope of their training data, the potential for biases, and their vulnerability to manipulation. Several crucial factors need to be considered, such as shifts in datasets, the danger of incorrectly linking confounding variables with true signals, the frequent presence of unintended biases in clinical settings, the need for algorithm interpretability, the establishment of dependable confidence measures for the models, and the difficulty of applying findings across diverse populations. As a result, healthcare providers should develop and implement a thorough strategic plan to integrate AI into healthcare, specifically addressing issues related to costs, technological infrastructure, and the practical application of AI systems for healthcare professionals [69-70].

4. Limitations of AI in Healthcare

For machine learning (ML) and deep learning models in healthcare to function effectively, they need large and robust datasets to accurately classify and predict a range of tasks. Nonetheless, the healthcare industry encounters considerable obstacles regarding data accessibility. Patient records are protected by confidentiality, and healthcare organizations (HCOs) often hesitate to share health data. In addition, once an algorithm is implemented with an initial dataset, obtaining additional data for refinement or improvement becomes challenging. Although ML systems are intended to evolve and enhance as they gather more training data, this continuous learning process is frequently obstructed by internal resistance within organizations.

Furthermore, AI-driven applications raise issues related to data security and privacy. Health records are frequently targeted by hackers during data breaches due to their high value and vulnerability to misuse. Therefore, it is crucial to safeguard the confidentiality of these health records [71].

5. Conclusion:

AI has the potential to diagnose illnesses, create tailored treatment strategies, and support healthcare professionals in their decision-making processes. Instead of merely automating tasks, the focus of AI is on creating technologies that improve patient care in various healthcare environments. Nevertheless, it is essential to tackle challenges concerning data privacy, biases, and the necessity for human expertise to ensure the responsible and effective use of AI in the healthcare sector.

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